

The storm was accompanied by some snow in the district and followed by a cold wave, but with diminishing intensity. The movement of the storm was amply covered by cold-wave and norther warnings, and by advisory messages to the vessel interests on Lake Michigan.

Still another cold wave appeared on the 14th in the British Northwest and overspread the Rocky Mountain region and eastern slope during the succeeding twenty-four hours, for which necessary warnings were issued. The storm preceding this cold wave moved from eastern Colorado to Lake Michigan in twenty-four hours, causing high winds on the lake. Vessel interests were warned as to the approach of the storm.

A fourth cold wave moved, during the 25th, 26th, and 27th, southward over the Rocky Mountain region and eastern slope; warnings were furnished to nearly all threatened points.—*H. J. Cox, Professor.*

**SAN FRANCISCO FORECAST DISTRICT.**

Prior to the 13th, the rivers in California were extremely low owing to the drought of the past season and the light rains of the present season up to that date. On the 23d, they began to rise quite rapidly. On the evening of the 24th, a forecast was made that "the lowlands, in the lower portions of the Sacramento and San Joaquin valleys would be flooded by Sunday, the 26th." This was fully verified. The crest of the high water was reached on the 26th, and the afternoon reports showed a general fall. The damage caused by the overflow was slight.

Wind signals were displayed on the 14th, 15th, 16th, and 17th, and again on the 22d and 28th. As usual these warnings were heeded and no disasters occurred.

On the morning of the 9th, the conditions shown on the weather map indicated severe frosts in California. Forecasts were issued at once giving warning of severe frosts throughout the State. Besides the regular distribution of these warnings by displaymen, the daily press, the maps, and forecast postal cards of the Weather Bureau, they were given to the Southern Pacific and San Francisco and San Joaquin Valley railroad companies, which caused the same to be bulletined by their agents throughout the State. Similar warnings were again issued on the 10th and 11th, and distributed in the same manner as were those of the 9th. The usual measures to prevent injury were resorted to, and it is believed with much success. Damaging frosts occurred on the mornings of the 10th, 11th, and 12th. Owing to the advanced stage of the fruit buds the almonds and apricots were seriously damaged, especially the former. Later developments, however, show the injury not so great as was at first anticipated.

On the 10th, warnings of severe frosts were sent to southern Arizona. On the morning of the 11th, Phenix reported a minimum temperature of 32°, but I have not been advised of any injury experienced.—*G. H. Willson, Local Forecast Official.*

**PORTLAND, OREG., FORECAST DISTRICT.**

River forecasts were issued on March 1, 2, 3, 4, 5, and 6. On March 2 a warning message was sent to the merchants and others in the threatened districts. The newspapers gave the warning great prominence.

Owing to the low stage of the Columbia, and the further fact that there was no rise in that river, the lower Willamette fully discharged its waters and it did not rise in this city as high as was expected; however, for all practical purposes the river forecast was verified.

The season has been backward and frosts were of frequent occurrence, no special frost forecasts were issued because they could be of no benefit.

Many sensational reports were published by the papers concerning damage done to fruit, wheat, and stock by the February freeze and unseasonable March weather, but information given on the subject by this office rapidly and readily checked the ill effects produced by the unwarranted reports.—*B. S. Pague, Forecast Official.*

**AREAS OF HIGH AND LOW PRESSURE.**

During March the tracks of eight highs and eleven lows were sufficiently well defined to be traced on Charts I and II, and the principal points regarding their place of origin and ending, duration, and velocity are given in the accompanying table. The ovals delineating these highs and lows were much better located this month than is ordinarily the case, and their progress across the country could be fairly well traced.

*Highs.*—All the highs began to the north of Montana, except the last, which began in Wisconsin. Four of them were last noted over Nova Scotia or Newfoundland; Nos. II and VI disappeared off the middle Atlantic coast, No. VII in the middle Gulf, and No. I to the north of Lake Superior. The general tendency was toward the east, but for three of the tracks toward the south and southeast. The sharp falls in temperature were as follows: As high No. III moved out of Manitoba on the evening of the 11th, Kansas City had a fall in temperature of 38° in twenty-four hours, and at 8 a. m. of the 12th Springfield, Mo., reported a fall of 36°. This cold wave moved rapidly north, and disappeared on the morning of the 13th over Ontario. On the morning of the 19th, while No. V was to the north of Montana, a fall of 36° occurred in northern Louisiana. On the evening of the 28th, as high No. VII approached the west Gulf, Montgomery reported a fall of 36°, and at the 8 a. m. report of the 29th a fall of 34°.

*Movements of centers of areas of high and low pressure.*

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
<b>High areas.</b>										
I.....	1, p. m.	52	116	4, a. m.	50	85	<i>Miles.</i> 1,950	<i>Days.</i> 2.5	540	22.5
II.....	4, a. m.	50	110	9, p. m.	49	80	2,280	5.5	415	17.3
III.....	9, p. m.	51	113	15, p. m.	47	59	2,520	6.0	420	17.5
IV.....	13, a. m.	53	115	18, p. m.	45	61	3,090	5.5	562	23.4
V.....	18, p. m.	55	108	23, a. m.	48	53	3,390	4.5	740	30.3
VI.....	20, p. m.	51	116	25, a. m.	37	75	2,220	4.5	493	20.5
VII.....	25, a. m.	52	119	29, a. m.	32	59	2,520	4.0	630	26.2
VIII.....	26, a. m.	43	90	29, a. m.	46	58	1,050	3.0	550	22.9
Total.....							18,960	35.5	4,850	181.1
Mean of 8 paths.....							2,370		544	22.7
Mean of 35.5 days.....									534	22.2
<b>Low areas.</b>										
I.....	*23, a. m.	48	134	3, a. m.	41	69	2,910	3.0	970	40.4
II.....	1, a. m.	34	98	6, a. m.	50	64	2,100	5.0	420	17.5
III.....	5, p. m.	36	89	8, p. m.	48	52	2,340	3.0	780	32.5
IV.....	6, a. m.	52	114	9, p. m.	42	73	2,100	3.5	600	25.0
V.....	8, a. m.	47	128	13, p. m.	47	50	3,960	5.5	720	30.0
VI.....	12, a. m.	49	124	17, a. m.	47	51	3,900	5.0	780	32.5
VII.....	14, a. m.	44	125	20, p. m.	49	62	3,720	6.5	572	23.8
VIII.....	19, a. m.	52	122	25, p. m.	47	56	4,710	6.5	725	30.2
IX.....	23, a. m.	51	124	27, a. m.	48	56	3,510	4.0	877	36.6
X.....	23, a. m.	37	105	30, a. m.	52	63	3,540	7.0	506	21.1
XI.....	28, p. m.	49	114	†1, a. m.	48	61	3,540	3.5	1,011	42.1
Total.....							36,330	52.5	7,951	331.7
Mean of 11 paths.....							3,303		724	30.2
Mean of 52.5 days.....									692	28.8

\*February. †April.

*Lows.*—Six of the lows originated in the north Pacific, No. IX to the north of Montana, No. X in Colorado, and Nos. II and III in the lower Mississippi Valley. The general movement was toward southeast and east. Nos. I and IV

were last noted off the New England coast, and the remaining nine over the Gulf of St. Lawrence or Newfoundland. The following high winds were reported on the evening of the 5th. As No. II passed across Ontario it caused a west wind of 64 miles an hour at Buffalo. On the morning of the 7th, as low No. III moved up the middle Atlantic coast, Block Island reported a northeast wind of 60 miles, and that same evening Eastport had northeast 60. On the morning of the 12th, as No. V moved to the upper Lake region, Chicago had 60 southwest. As low No. VI moved into Ontario, Buffalo had southwest 56. As low No. VII moved to the New England coast it caused the highest wind of the month, 72 miles from northwest at New York on the evening of the 19th, and the same station reported previously the same velocity and direction on the evening of the 29th as low No. X approached the Atlantic coast.

### RIVERS AND FLOODS.

Nothing of importance in connection with river stages occurred during March, 1899, in that portion of the Mississippi River system north of Cairo. After the ice broke at Dubuque and south of Omaha during the second decade of the month there was a rapid rise in both the Mississippi and Missouri, due to comparatively heavy rains, but no high stages were reached except in the Illinois River. At Peoria the river was above the danger line of 14 feet from the 13th to the 28th, inclusive, reaching a stage of 15.1 feet on the 22d. At Beardstown stages above the danger line of 12 feet occurred during the entire month, with a maximum stage of 15.1 feet on various dates between the 6th and 14th.

East of Cairo the headwaters of the Ohio system rose rapidly from the 3d to the 6th, on account of heavy rains, particularly in West Virginia. At Charleston, W. Va., the Kanawha River rose 30.7 feet from the morning of the 4th to midnight of the 5th, reaching a stage on the latter date of 41.5 feet, 11.5 feet above the danger line, and with one exception the highest recorded stage. The highest previous stage was 46.9 feet, in September, 1861.

At Pittsburg there was a rise of 10 feet during the same time, a stage of 22.0 feet, just the danger line, having been reached. The crest of this rise reached Wheeling, W. Va., on the 7th and Parkersburg on the 8th. At Point Pleasant, W. Va., the rise from the Kanawha hastened the crest stage, and on the 7th there were 47.2 feet of water on the gauge, 8.2 feet above the danger line.

The necessary warnings were issued from Parkersburg on the 4th and 5th for the rises at Charleston and Point Pleasant. Commendatory notices of these warnings were received later, and the following extracts are taken from the special report of Mr. J. W. Crider, River Observer at Charleston, W. Va.:

This flood came upon us more suddenly than any previous one within my recollection. From a stage of 10.8 feet on the 4th, the river rose to 41.5 feet by midnight of the 5th. Special warnings from Hinton, W. Va., and information obtained by telephone from the United States Engineers as far above as Kanawha Falls prepared the people of this city, and by night of the 4th nearly all in the flooded district had removed to places of safety. On the morning of the 5th, when the gauge stood at 36.7 feet, I posted a notice that the river would continue to rise until it reached 41.3 feet. It did reach this stage, and exceeded it by 0.2 foot at midnight. Beyond the inconvenience and loss of time suffered by business interests, the damage was trifling. The fact that great loss did not occur can only be attributed to the timely warnings issued by the Weather Bureau. The smaller towns along the river did not fare so well. At Winifrede the dry docks and ten barges were swept away, and several coal tipples at other points were taken.

This rise also reached Catlettsburg, Ky., on the 7th, with a stage of 56.3 feet, 6.3 feet above the danger line, and Portsmouth, Ohio, with a stage of 55.8 feet, 5.8 feet above the dan-

ger line. Damage to the amount of \$1,000 was caused by the flood at the latter place. The Licking River was also in flood, reaching 27.7 feet at Falmouth, Ky., on the 5th, 2.7 feet above the danger line. The following history of this flood was furnished by Mr. S. S. Bassler, Official in Charge of the United States Weather Bureau Office at Cincinnati:

On Saturday, the 4th instant, the reports showed a tremendous rise in the Great Kanawha and other mountain streams, and the announcement was at once published and otherwise disseminated, that the storm then in progress was materially changing the river situation and that during Sunday and Monday the river would rise rapidly here with prospects of more water than we have had this winter.

On Sunday morning (5th) warning was issued that the river would exceed the danger line (50 feet) by Monday morning, equivalent to a rise of 6 feet. Railroad officials and merchants in the bottoms were notified as far as possible and all took prompt action. The danger line warning was telegraphed to Portsmouth, Ohio, and Catlettsburg, Ky., and warning sent to Louisville, Ky. Residents along the river bottoms were warned, through the police department, of a 50-foot stage by morning, and continued rising waters. By request I telegraphed the situation to the editor Daily Blade, Portsmouth, Ohio, giving him warning of stages above danger line from Point Pleasant down. Although it was Sunday the telephone was in constant use, and merchants first affected by the rising water were busy removing goods out of the cellars.

On Monday morning, March 6, the stage here was 50.3 feet and at Catlettsburg and Portsmouth it had passed the danger line. The forecast was issued as early as possible that the stage would reach 56 feet by Tuesday morning. Flood warnings were telegraphed to the mayors of Higginsport and Ripley, Ohio, Lawrenceburg and Vevay, Ind., and to the wharfmaster at Maysville, Ky. Long distance telephone and telegraphic communication was held with various points from Portsmouth, Ohio, to Lawrenceburg, Ind.

On Tuesday morning, March 7, the stage was 55.1 feet, the high winds and cold wave of Monday night undoubtedly preventing the forecast stage. Tuesday morning's forecast stated that the river would come to a stand by Wednesday morning and would not exceed 58 feet. This announcement from the Weather Bureau was a relief, and merchants whose property was not in danger at 58 feet refrained from incurring the expense of removing it.

On Wednesday morning, March 8, the river at Cincinnati was apparently on the stand at 57.2 feet and the forecast for the day was that the river was practically stationary and would remain so for several hours, possibly rising a tenth or two more, and then begin falling.

To save apparently unnecessary expense to the public the forecast limit of 58 feet was changed to 57.5 feet.

The observers at Louisville, Ky., and Cairo, Ill., were notified by telegraph, and the mayor of Lawrenceburg, Ind., by long distance telephone, of the river conditions here. Between 7 and 8 a. m. the stage rose to 57.3, where it remained until noon, when it fluctuated slightly until 4 p. m., when it had risen to 57.4 feet and there remained until 9 p. m., when it began slowly falling.

The singular fluctuation as recorded by the gauge a part of the day is believed to have been caused by the strong variable winds then prevailing.

The water at Cincinnati remained above the danger line (50 feet) from 6 a. m. of the 6th to 2 p. m. of the 11th.

By reason of the timely warnings, admitted on all sides, and the general readiness for the approach of high water, the loss here was unusually slight. The heaviest loss was to railroad and steamboat interests, and to the latter through inability to pass under the bridges, thereby losing trips.

At Catlettsburg the highest stage (56.3 feet) occurred at 4 a. m. of the 7th, when it was stationary for twelve and one half hours.

At Portsmouth the highest stage (55.8 feet) occurred at 6 a. m. of the 7th, when it was stationary for ten hours.

At Maysville the highest stage (54.1 feet) occurred during the afternoon of the 7th, when it was stationary about six hours.

At Cincinnati the highest stage (57.4 feet) occurred at 2 p. m. of the 8th, when it was stationary seven hours.

The crest reached Louisville on the 10th, with a stage of 52.8 feet, 4.8 feet above the danger line. At Evansville the danger line of 35 feet was reached on the 4th, and the crest stage of 42.7 feet on the 12th. Lowlands above and below the city were flooded, but the only annoying feature was the temporary inconvenience.

The Wabash River also contributed its full share to the general flood, reaching a stage of 18.6 feet at Mount Carmel, Ill., on the 7th, or 3.6 feet above the danger line, and remaining above this point until the 12th.

The flood also extended in a lesser degree to the Tennessee River and tributaries. At Clinton, Tenn., the Clinch River